

Aus der Veterinär-Chirurgischen Klinik der Universität Zürich
(Prof. Dr. P.F. Suter)

und aus der Ohio State University, College of Veterinary Medicine,
Department of Clinical Sciences
(Dr. L.R. Bramlage, DVM MS)

MANDIBULAR AND MAXILLARY FRACTURES

A REVIEW OF 46 CASES

Inaugural-Dissertation

zur Erlangung der Doktorwürde
der Veterinär-Medizinischen Fakultät
der Universität Zürich

vorgelegt von
ROMAN LOPPACHER
Tierarzt
von Teufen AR

Genehmigt auf Antrag von
Prof. Dr. P.F. Suter, Referent
Dr. L.R. Bramlage DVM MS, Korreferent

Zürich 1987
Zentralstelle der Studentenschaft

Aus der Veterinär-Chirurgischen Klinik der Universität Zürich
(Prof. Dr. P.F. Suter)

und aus der Ohio State University, College of Veterinary Medicine,
Department of Clinical Sciences
(Dr. L.R. Bramlage, DVM MS)

MANDIBULAR AND MAXILLARY FRACTURES

A REVIEW OF 46 CASES

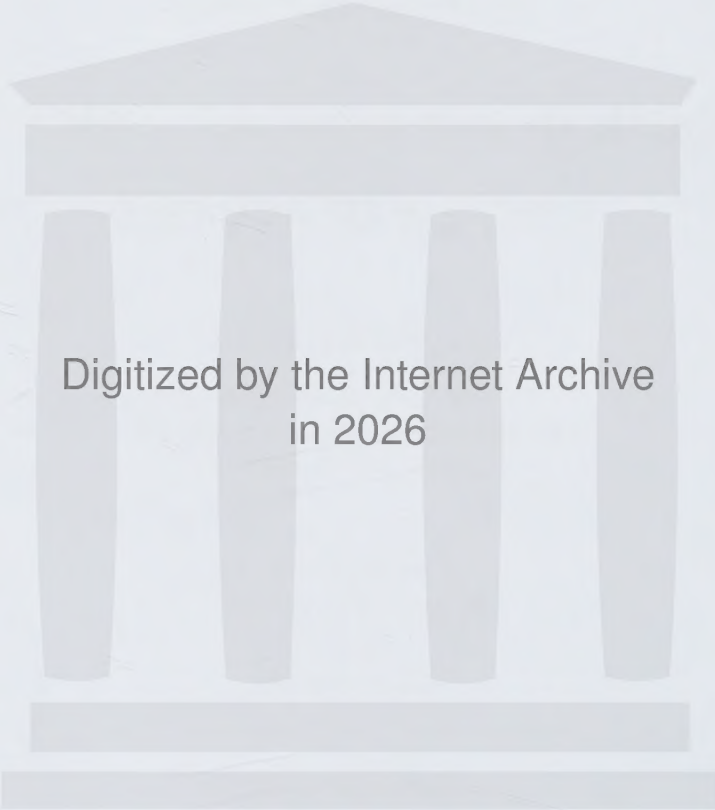
Inaugural-Dissertation

zur Erlangung der Doktorwürde
der Veterinär-Medizinischen Fakultät
der Universität Zürich

vorgelegt von
ROMAN LOPPACHER
Tierarzt
von Teufen AR

Genehmigt auf Antrag von
Prof. Dr. P.F. Suter, Referent
Dr. L.R. Bramlage DVM MS, Korreferent

Zürich 1987
Zentralstelle der Studentenschaft



Digitized by the Internet Archive
in 2026

Many Thanks to my Parents

Dedicated to

Linda and Andrea

CONTENTS

1. Introduction
2. Materials and Methods
 - 2.1. Clinical Signs and Diagnosis
 - 2.2. Surgical Procedures and Postoperative Management
3. Results
4. Discussion
5. Summary
6. References

Mandibular and Maxillary Fractures

A Review of 46 Cases

1. Introduction

The mandible and the maxilla are the most commonly fractured bones in the equine head (13). The rostral aspects of the mandible or the maxilla are most often involved. Fractures of the molar and premolar parts of the horizontal ramus and fractures of the vertical ramus of the mandible are less frequent. Maxillary fractures caudal of the upper first cheektooth (second premolar, P₂) were not presented to our clinic during the period of our investigation.

In a literature study (Hurtienne and Wissdorf, 1972) 17 out of 27 mandibular fractures (63%) involved the interalveolar space of the mandible. In 47 cases of jaw fractures, 28 (60%) included fractures located rostral of the premolar teeth. The smallest number of cases (7 horses or 15%) were fractures of the vertical ramus of the mandible (16).

Traumatic insults, such as kicks, falls or startles of a horse chewing on a fixed object, are the usual causes of these fractures. Intramedullary pins (1,7), ASIF-plating (2, 8, 9, 10), lag-screw fixation (12), Kirschner appliances (3) and various methods of external fixation (4, 5, 6, 11, 15, 17) have been used to stabilize these fractures.

External fixation methods included the use of a U-shaped brass rod fitted to the tooth arcade of the upper (Krahwinkel, 1969) or lower jaw (Gabel, 1969). The rods are attached to the incisor teeth and first two cheekteeth on both sides with cerclage wire.

Technovit^R splints were used to connect pins that were transversely placed through the mandible rostral and caudal to the fracture stabilizing the fracture adequately for healing (Ammann, 1970, Hurtienne, 1972, "Beckersche Kunststoffbrücke").

However, the disadvantage of this device is its bulkiness and high risk of damage by the patient.

Braces made from thermoplastic material have been used on the labial side of the incisor teeth to compress and stabilize rostral mandibular fractures. A tension band attached to the external brace was anchored in a drill hole through the ramus of the mandible (Monin, 1977).

One case of a cerclage wire repair of a rostral mandibular fracture was described in an 8 month old Quarterhorse filly. The result of the repair was reported to be positive (Asquith, 1979).

Seven cases of rostral mandibular fractures were reviewed by DeBowes (1981). The method of repair was a lag screw technique for compression and fixation. Through a stab incision in the mandibular gingiva, cortical bone screws were used to lag the fracture fragment to the parental bone. The outcome of all seven cases was reported to be very favorable.

Fractures of the mandible and the maxilla offer a good prognosis for surgical repair by numerous methods, provided one is able to immobilize and reduce the fragments adequately. The excellent healing ability of the bones of the head is probably due to the very rich blood supply of this area (Gabel, 1969), and due to the fact that these bones are primarily cancellous in nature, lacking the dense cortex which is present in most long bones.

The purpose of this paper is to review 46 consecutive cases of mandibular and maxillary fractures presented to the Veterinary Hospital of the Ohio State University from 1976 until 1984, to examine the repair methods used, and to determine the results of the treatment methods used. The different injuries were analysed and classified, and based on the results of the various treatments, certain principles of treatment of jaw fractures were recommended for use in future fractures.

2. Materials and Methods

The medical records of all jaw fractures referred to our hospital between January 1976 and December 1984 were retrieved. Radiographs were used to classify the various types of fractures. In cases where the aftercare was done by the referring veterinarian and the outcome was not obtainable from the medical records, the referring veterinarian or the owner of the animal was called and questioned about the result.

2.1. Clinical Signs and Diagnosis

Most of the horses exhibited crepitation or instability of the mandible or the maxilla or both when the jaws were manipulated. Protrusion of the tongue or of some or all of the incisor teeth between the lips was observed in most cases. In some horses anorexia was the major complaint.

A typical foul odor from the horses' mouths was present when the injury had occurred several days prior to presentation. This odor (*foetor ex ore*) originated from decaying feed material and rancid blood present in the fracture plane. In all horses where a fracture of the mandible or the maxilla was diagnosed or suspected during physical examination, a radiographic evaluation was done to confirm the findings. A lateral view of the rostral part of the head was taken in all cases. And, if necessary, for better demonstration of the fracture line(s), ventro-dorsal or oblique views were also taken.

To classify the fractures as to difficulty and success of treatment the following categories were used:

- I - Fractures involving the incisor teeth and the incisive part of the mandible or the maxilla, 13 cases. (fig 1, 2, 3, 4, 5)

- II - Fractures through the interalveolar space of the mandible or the maxilla, 14 cases. (fig 9, 10, 11)

- III - Comminuted fractures through the angle of the mandible and through the horizontal mandibular ramus, 2 cases.
- IV - Minimally displaced fractures and old injuries with an already formed fibrous union, 12 cases.

Treatment categories:

- I - Intra-oral wiring between incisor teeth.
- II - Intra-oral tension band wires between incisor teeth and caudal anchor (canine tooth, first cheektooth or horizontal ramus of the mandible).
- III - Internal fixation using compression plates (AO/ASIF - technique).
- IV - Treatment without surgical fixation.

2.2. Surgical Procedures and Postoperative Management

Category I (see table 1)

Intra-oral wiring alone was the treatment preferred in most of these fractures. In category I, involving the incisor teeth and the incisive part of the mandible or the maxilla, wiring was used exclusively, (fig 1, 2, 3). One exception was case *5, where displacement and size of the fracture fragment required additional fixation with cortical bone screws.

In horses with minimal displacement and associated damage, if uncomplicated surgical repair was anticipated, the repair was done standing with sedation and local anesthesia only.

In more complicated cases the horses were premedicated with xylazine^a (2 mg/kg IM) and anesthesia was induced with thiamylal^b (3-4 mg/kg IV),

^a Rompun[®], Bayvet Div., Miles Laboratories Inc., Shawnee, KS

^b Surital[®], Parke Davis and Company, Detroit, MI

guaifenesin^c (50 mg/kg IV, 5% solution) and thiamylal or ketamine^d (2 mg/kg IV) and maintained with halothane^e.

To increase exposure to the mouth and fracture, the horses were sometimes intubated through the nose or a tracheostomy was performed and the endotracheal tube was inserted through the artificial opening in the trachea.

Thorough cleaning and flushing of the fracture gap removing blood clots and feed material was done to assess the damage to the bone and teeth and to allow accurate reduction.

Careful debridement was done with bone curettes to expose raw bone for optimum healing. Irreversibly damaged incisor teeth were removed, especially if the teeth were deciduous. Teeth that were slightly loose and those with minor damage (such as a longitudinal crack), were usually left in place and had a good chance to heal. Obviously, they could not be used as an anchor for the tension wires. After debridement of all the dead tissue and foreign material, the fracture was reduced to obtain the best possible alignment of upper and lower incisors. With the aid of 14 ga disposable hypodermic needles used as canulas, orthopedic wire (1.2 mm) was threaded through the space between the incisors adjacent to the fracture line and laced through the remaining adjacent incisors (fig 6, 8). The loose ends were tightened on the labial side of the incisor teeth. Depending on the individual fracture, a second or even a third tension wire was often placed to improve the stability of the fracture repair.

In one case (*5) the fracture extended from between the first and second incisor on the left side and broke through the lateral left side of the mandible just rostral to the first cheektooth. After wiring the incisors, this fragment was additionally stabilized with three 4.5 mm diameter cortical bone screws. This method is similar to the one described by DeBowes (1981). The screws were inserted through a stab incision in the mandibular gingiva. Using standard AO/ASIF technique the fracture fragment was lagged to the parental bone.

^c Guaifenesin, Gaines Chemical Inc., Carlstadt, NJ

^d Ketaset^R, Bristol Laboratories, Syracuse, NY

^e Halothane, Ayerst Laboratories Inc., New York, NY

Postoperatively the horses of this category were kept at the hospital for an average of three days. Five patients were treated as outpatients. The maximum stay of one patient was ten days. They were allowed to eat a normal ration usually starting the first postoperative day. The diet consisted of mixed grain and hay and fresh water free choice. No grazing was allowed.

All horses were treated with antimicrobials^f (Procaine Penicillin G in aqueous suspension 300'000 iu/ml, 22'000 iu/kg IM twice daily or Sulfamethoxazole and Trimethoprim oral suspension USP, 10 mg/kg twice daily) and tetanus toxoid. The antimicrobial therapy was prescribed for at least three consecutive days, depending on the individual case.

The horses' mouths were flushed daily, initially, to remove feed material and blood that became trapped between the wires and the gums. Once the bleeding ceased the flushing was stopped. At the hospital the wires were checked for displacement daily and were tightened if they became loose. For aftercare, the owners were instructed to check the wires twice a week. The wires were removed by the referring veterinarian or at our hospital four to six weeks after the repair. Wire removal was done under sedation. The cortical bone screws in case *5 were left in place.

A defect was considered as healed when it was mechanically stable and the buccal mucosa covered the fracture site. Follow-up radiographs were not taken.

^f Procaine Penicillin G, Pfizer, Sulfatrim Pediatric Suspension^R, Barre Drug Company

Table 1. Individual cases with results

Category I - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Result</u>
1	MC	QH	1 yr	fig 1D, 2, 3	I	good
2	M	App.	1 yr	fig 1A	I	lost to follow-up
3	M	Morgan	1 yr	fig 1A	I	good
4	M	Belgian	1 yr	fig 1C	I	fair (slight malalignment)
5	F	QH	4 yr	fig 1A (extending back to just cranial of P ₂)	I (plus lag screw fixation)	good
6	F	Belgian	1 yr	fig 1B	I	good
7	M	Stand.	2 yr	fig 1D	I	good
8	Mc	Stand.	8 yr	fig 1B	I	good
9	F	Belgian	9 mo	fig 1A	I	good
10	F	?	1 yr	fig 1C, 4	I (fig 8)	good
11	M	Tenn. W.	14 yr	fig 1A	I	good
12	M	QH	2 yr	fig 1A	I	good
13	M	Arab	2 yr	fig 1A	I	good

Mc Male castrated

M Male

F Female

QH Quarterhorse

App. Appaloosa

Stand. Standardbred

Tenn. W.

TB

Shet.

Perch.

Tennessee Walker

Thoroughbred

Shetland Pony

Percheron

fig 1 This illustration demonstrates the fracture patterns involving the incisor teeth and incisive part of the mandible (category I). A and B are the most common fracture lines. They start between two incisors and break out laterally. C is a sagittal type fracture, D shows the breaking out of three incisors.

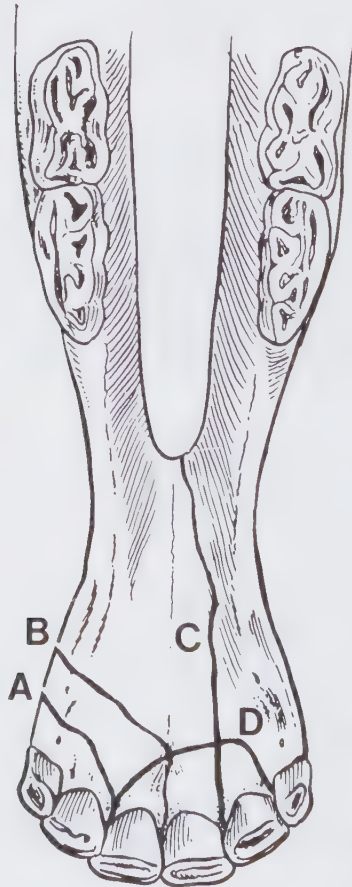


fig 2 Lateral radiograph of case *1 with a type 1D fracture of the maxilla. The arrow indicates the displaced incisors.

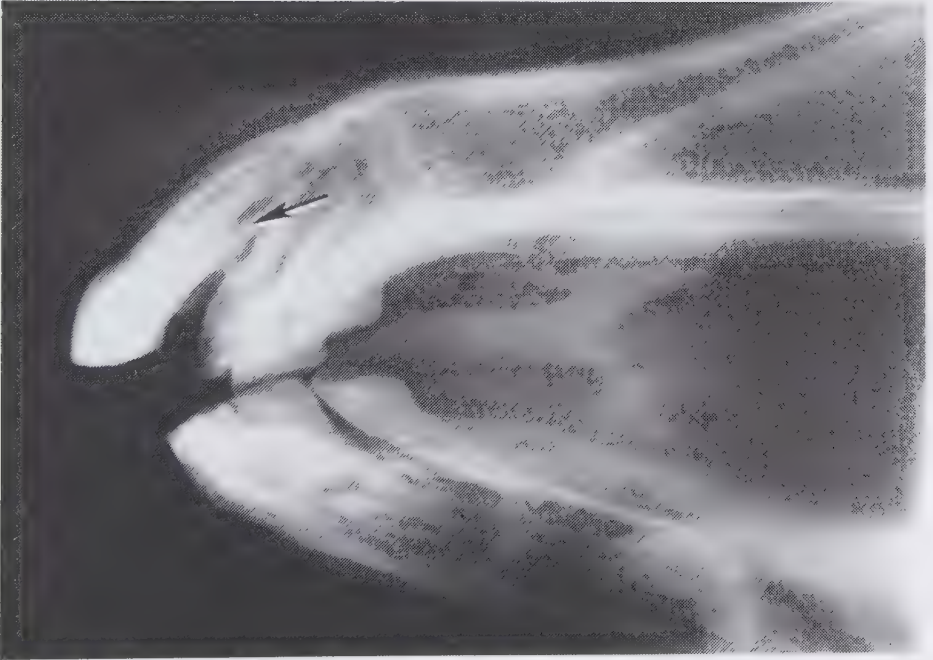


fig 3 Dorso-ventral radiograph of case *1 with a type 1D fracture of the maxilla.
The arrows indicate the extent of the fractured incisive part of the bone.



fig 4 Dorso-ventral radiograph of case *10 with a sagittal type 1C fracture in the mandible. The arrows indicate the wide fracture gap.

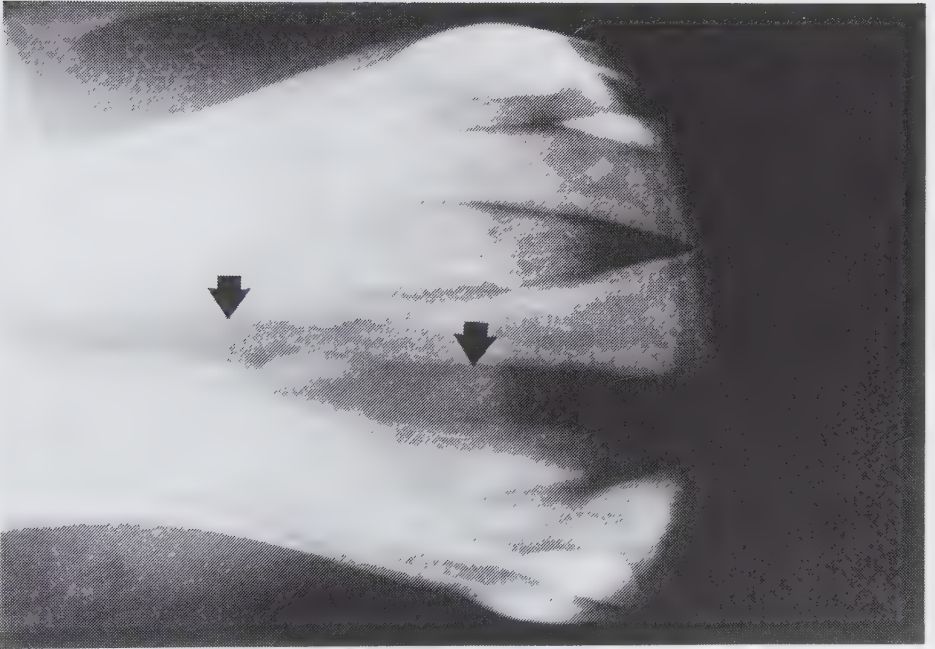


fig 5 This illustration depicts a simple displaced type B fracture involving the incisive part of the mandible.

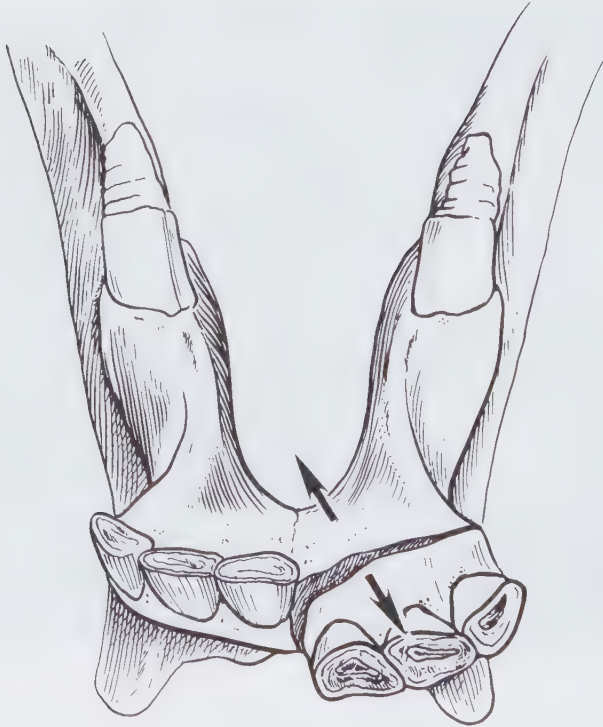


fig 6 This drawing illustrates the placement of orthopedic wire (1.2 mm) with the aid of a 14 ga hypodermic needle used as a guide.

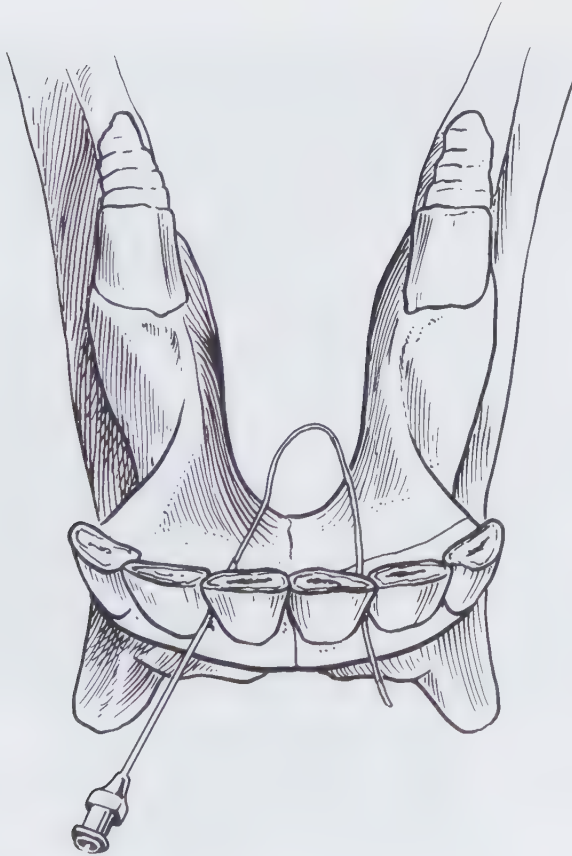


fig.7 This figure illustrates a fracture type 1B with the accomplished reduction through tension wire placement (arrow 1). Arrow 2 indicates the direction of the occlusional forces during mastication. Arrow 3 indicates the compression forces across the fracture.

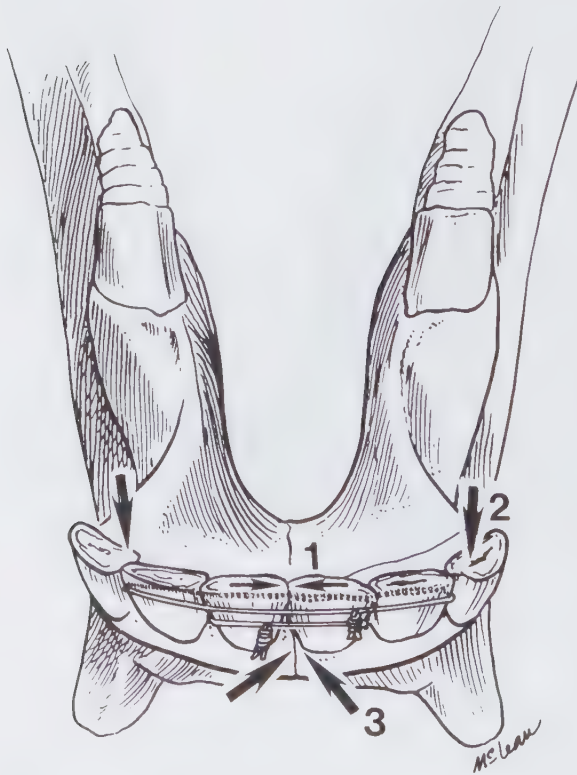


fig 8 Dorso-ventral radiograph of case *10 illustrating the repair of a sagittal fracture with orthopedic wire. The arrow points to the much smaller fracture gap after reduction (compare fig 4).



Category IIa (see table 2)

These cases included fractures through the interalveolar space of the mandible or the maxilla separating the incisor teeth completely from the rest of the bone (fig 9, 10, 11).

Preparation for surgery was the same as described before. Thorough cleaning, flushing and debridement of the open fracture was an important step to assess the amount of damage.

With a 3.2 mm drill bit a hole was drilled between the first and second cheektooth. Access to these teeth was via a stab incision through the cheek. Care was taken to avoid the vein of the upper lip (vena labialis maxillaris). The hole was drilled through the stab incision between the bases of the teeth at the gum line. An orthopedic wire (1.2 mm) was passed between P₂ and P₃ and pulled cranially. Fixation around the incisor teeth was performed by lacing the wire around the incisors with the aid of needles (fig 12, 13, 14). To tighten the wires on either side of the jaw they were twisted, like a turnbuckle, with a hemostat or another suitable instrument until the fracture was reduced totally and became stable.

In horses with fractures between the incisor teeth as well as across the interdental space, the repair was done as described above but the placement of the tension band wires between incisors and premolars was done after the interincisor fractures were reduced and wired. This way, a one piece fragment was created.

In four horses (*20, 21, 23, 24) with fractures in the interdental space rostral to well developed canine teeth and caudal to the incisors, the same tension band-turnbuckle system was used, but instead of P₂ the canine tooth served as the caudal anchor for the wire. To anchor the wire a groove was rasped on the caudal surface at the base of the canine tooth at the gingival margin. The groove had to be deep enough that the tightened wire could not slip.

In one horse (*18) with bilateral unstable fractures of the horizontal mandibular rami at the level of P_3 and P_4 and disruption of the soft tissues ventrally, it was necessary to reconstruct the ventral support before the tension wire could be placed. Using standard AO/ASIF technique, narrow 4.5 mm dynamic compression plates⁹ were placed ventrally on each ramus to prevent opening of the ventral aspect of the fracture line upon tightening of the tension wire. The alveolar border of the fracture was then stabilized with tension band wire repair to the first stable cheekteeth caudal to the fracture as with other injuries of this type.

In horse *17 with bilateral fractures of the horizontal mandibular rami in the interdental space, and instability of the ventral aspect of the fracture gap, similar to horse *18; two 4.5 mm diameter cortical bone screws were placed across the fracture line to stabilize the ventral fracture before the alveolar borders were stabilized with orthopedic wire. Using standard AO/ASIF lag screw technique the cortical bone screws were inserted through a stab incision in the skin on the ventral border of the mandibular ramus.

In horse *22 where the rostral fragment containing the incisor teeth was fractured longitudinally, the ventral fracture lines of the fragments were aligned and stabilized with crossed pins and cerclage wires before the tension band wire was placed intra-orally.

Postoperatively these horses were kept at the clinic for an average of six days. The postoperative care was the same as for the horses of category I, (page 6).

⁹ Dynamic compression plate (DCP), Synthes Ltd., Wayne, PA

Table 2. Individual cases with results

Category IIa - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Result</u>
14	F	Stand.	2 yr	fig 9A (maxilla)	IIa	good
15	F	TB	1 yr	fig 9A, 11 (mandible), fig 9B (maxilla)	IIa (fig 14)	good
16	F	Paint	2 mo	fig 9B, 10	IIa	good
17	F	Albino	8 yr	fig 9B	IIa (plus lag screw fixat. from ventral side)	good
18	F	Stand.	3 yr	fig 9B at the level of P ₃ /P ₄ respectively	IIa (plus DCP from ventral side)	died post-surgic. due to salmonella infection
19	F	Arab	4 mo	fig 9B	IIa (on left ramus only)	parrot mouth
20	Mc	Arab	9 yr	fig 9A	IIa (tension band back to canine)	good
21	Mc	Stand.	5 yr	fig 9A	IIa (tension band back to canine)	good
22	F	Stand.	7 yr	fig 9B (mandible plus symphyseal fracture) fig 9B (maxilla)	IIa (plus pin and cerclage, mandible) IIa (maxilla)	euthanasia post-surgic. because of myopathy
23	Mc	TB	12 yr	fig 9C	I and IIa (tension band back to canine)	good
24	Mc	QH	9 yr	fig 1B	I and IIa (tension band back to canine)	good

fig 9 This illustration demonstrates the fracture patterns where more than intra-incisor wiring was necessary to achieve sufficient stabilization. A is a transverse fracture line just caudal to the incisors. B is one of the possible transverse fracture lines through the interalveolar space. C is the fracture line of case *23 (symphyseal fracture plus transverse fracture of the right fragment). D is the fracture line of case *30.

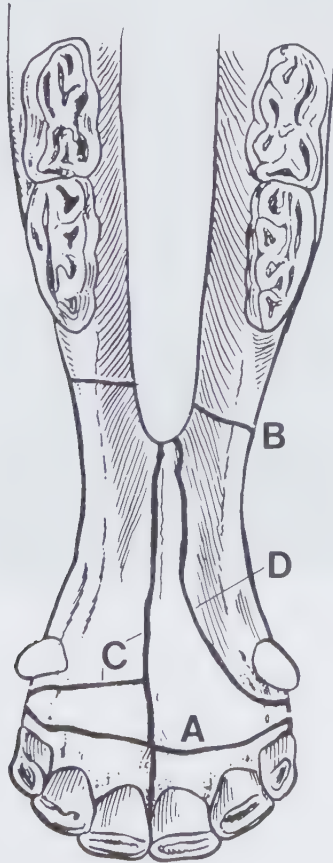


fig 10 Lateral radiograph of case *16 with an oblique type 9B fracture of the mandible. The arrow points to the fracture gap.

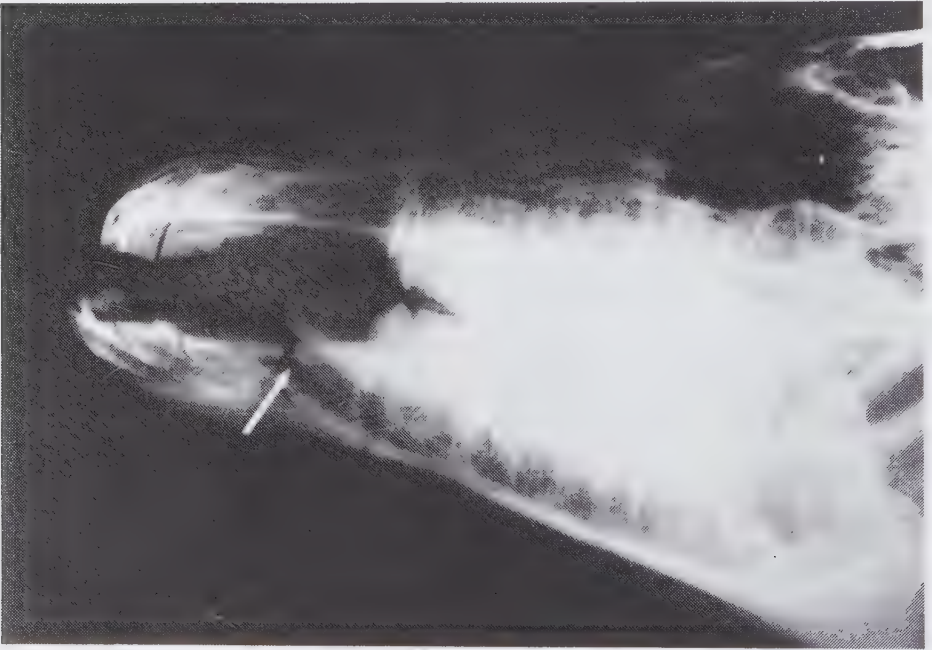


fig 11 Lateral radiograph of case *15 with an oblique fracture of both the mandible and the maxilla. The arrows indicate the displaced ventral incisors and the dorsal end of the fracture gap in the maxilla.

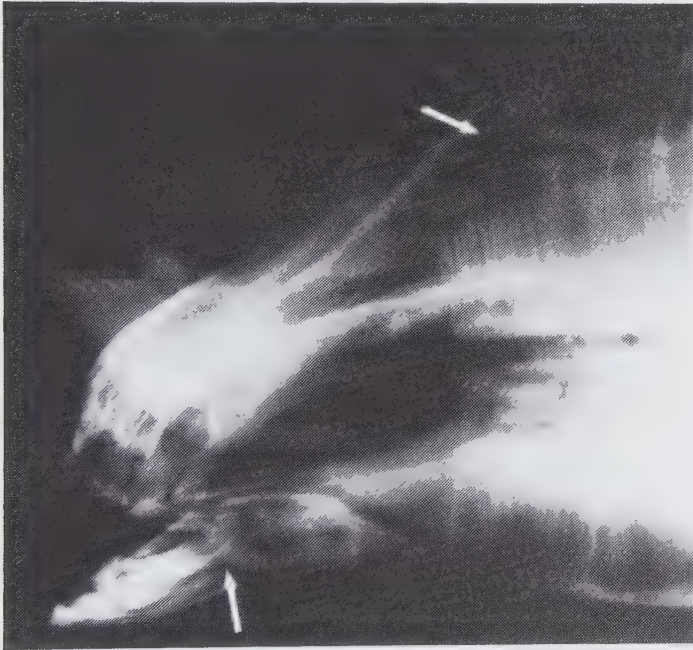


fig 12. 13 These illustrations show the tension wire placement for reduction of a transverse fracture through the interalveolar space.

fig 12

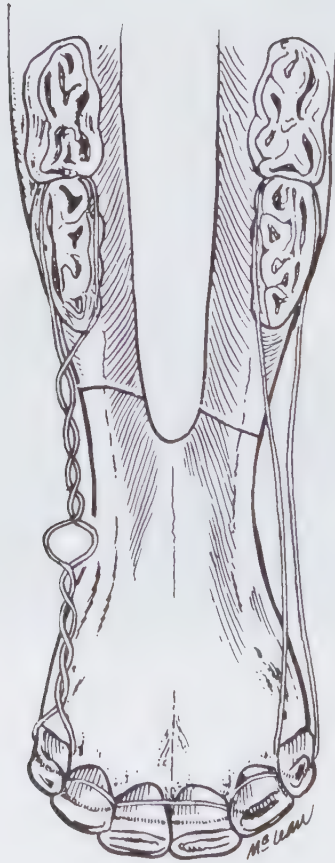


fig 13

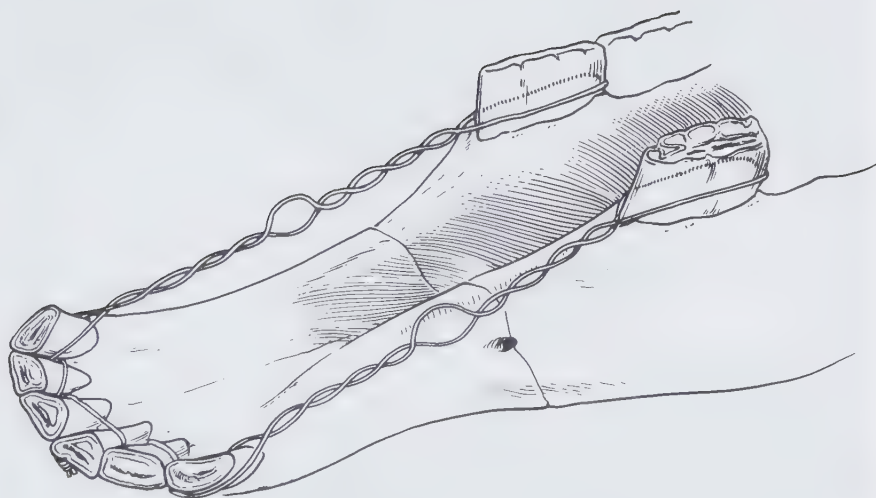
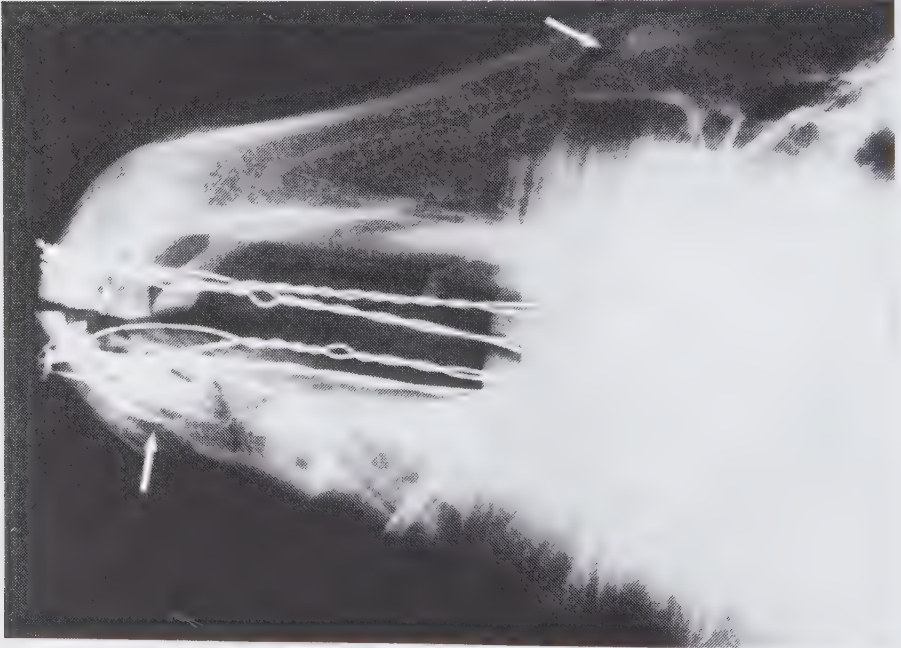


fig 14 Lateral radiograph of case *15 after placement of the intra-oral tension band wires. The arrows point to the not quite perfectly reduced fracture gap. However, the repair was adequate to achieve healing.



Category IIb (see table 3)

Three horses (*25, 26, 27) with fractures of the interdental space were repaired with a U-shaped brass rod as previously described by Gabel (1969). These fractures were very unstable. Case *26 presented as a compression fracture of the maxilla with the upper incisor teeth displaced caudally. The fracture line ran transversely through the premaxilla caudal to the roots of the incisor teeth. Case *27 presented as a double level fracture through the maxilla. In case *25 the two lower central incisors were missing.

A brass rod (8 mm diameter) was shaped to the arcade of the horses' incisor teeth and extended parallel to the horizontal jaw bones back to lateral of the first two cheekteeth. At the level of the anterior end of the first cheektooth (P_2) a hole was drilled through the rod. Two holes were drilled at the level of the first intertooth space (between P_2 and P_3). One last hole was drilled at the level of the second intertooth space (between P_3 and P_4). The holes were big enough to accomodate 18 gauge orthopedic wire. At the gum line, between the bases of the first and second and also between the second and third cheektooth, holes were drilled through a stab incision across the cheek. The same procedure was done on the opposite side. Once the rod was put into place, the wire loops were laced through the corresponding holes in the brass rod around the first and second cheektooth from lateral to lingual. Before tightening these wires, the fracture was reduced and the incisor teeth were fixed to the rod with cerclage wire. Then, the caudal wire loops around the first and second cheekteeth could be tightened.

The postoperative care for these patients was similar to that described above, (page 6). The patients stayed at the clinic for an average of 13 days (1 to 28 days).

Table 3. Individual cases with results

Category IIb - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Results</u>
25	F	Stand.	2 yr	fig 9A	U-bar fixation	good
26	M	App.	1 yr	fig 9A (maxilla)	U-bar fixation	good
27	Mc	Paint	22 yr	fig 9A (at two levels of the maxilla)	U-bar fixation	good

Category IIc (see table 4)

Four horses (*28, 29, 30, 31) were repaired with tension band wiring between incisor teeth and holes drilled caudal to the fracture line through the mandible to serve as the caudal anchor (similar to Monin, 1977).

The wiring around the incisor teeth was similar to the method described in category IIa, but the tension band was threaded caudally through holes drilled horizontally in the mandibular bone caudal to the fracture line instead of the first cheektooth. This drill hole served as the caudal anchor for the tension wire.

The patients stayed at the clinic for an average of four days. One of them was treated and released on the same day. The maximum stay was ten days. The post-operative care was the same as for the horses of category I, (page 6).

Table 4. Individual cases with results

Category IIc - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Results</u>
28	M	TB	1 yr	fig 9B	IIc	good
29	M	App.	8 day	fig 9B	IIc	good
30	M	Perch.	1 yr	fig 9D	IIc	fair (slight malalignment)
31	Mc	Belgian	2 yr	fig 9B	IIc	good

Category II d (see table 5)

In one horse (*32) with an interdental fracture, adequate reduction was achieved with orthopedic wire anchored in the horizontal ramus of the mandible caudal and rostral to the fracture plane. A Steinman pin across the fracture gap on one side provided additional stability. With the lower lip retracted, the Steinman pin was inserted from cranial to caudal parallel to the ventral margin of the mandible.

The postoperative care was the same as for the horses of category I, (page 6).

Category III (see table 5)

Two horses (*33, 34) were treated with internal fixation using only dynamic compression plates.

Case *33 presented as a comminuted fracture through the angle of the right mandible. The main fracture line ran from dorsal-cranial to ventral-caudal. To achieve sufficient stability a 3.5 mm 6-hole dynamic compression plate was used for fixation. Using standard AO/ASIF technique, the plate was put in place laterally along the edge of the mandible with 3.5 mm diameter cortical bone screws. To approach this area the skin was incised along the curve of the mandibular angle. The masseter muscle was separated carefully from the underlying bone structure. Great attention was paid to avoid injury to the masseteric branch of the external carotid artery (arteria carotis externa). A Penrose drain was placed between the muscle and the mandible to insure adequate drainage. Four days after surgery, when the draining stopped, the drain was pulled and the incision healed without complications. The implant was not removed. The patient was released from the hospital 33 days after surgery.

Case *34 was presented with a comminuted fracture of the left mandible at the level of the first cheektooth. When presented to our clinic the injury had been present for six days and was complicated by osteomyelitis. Under general anesthesia the fracture site was carefully debrided and cleaned. The first two cheekteeth had to be removed because they were shattered. Because much of the structural stability was lost in this case, a narrow 4.5 mm 9-hole compression plate was used on the

Table 5. Individual cases with results

Category IId - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Result</u>
32	F	Stand.	3 wk	fig 9B	wiring through holes on both sides of fractures plus Steinman pin	good (implant left in place)

Category III - fractures

33	F	?	4 mo	comminuted fracture through the angle of the right mandible	3.5 mm 6-hole dynamic compression plate	good (implant left in place)
34	F	TB	9 yr	comminuted fracture of type 9B in fig 9 of the left mandible cranial of P ₂ , complicated with osteomyelitis	narrow 4.5 mm dynamic compression plate (9-hole)	good

ventro-medial aspect of the mandibular bone. The approach was made via a skin incision along the ventral margin of the mandible.

The postoperative care was similar to the one for the horses of category I, (page 6). The antimicrobial therapy was extended until complete healing of the skin wounds occurred.

Category IV (see table 6)

Twelve horses (*35 - 46) were treated non-surgically because the fractures were judged to not require surgical intervention.

Four cases (*35, 42, 43, 44) presented as minimally displaced fractures that were judged stable enough to heal without surgical fixation. Three of them involved the

Table 6. Individual cases with results

Category IV - fractures

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>		<u>Fracture</u>	<u>Fixation</u>	<u>Result</u>
35	M	QH	3	mo	fig 9A, non-displaced fracture of maxilla	soft tissue repair only	good
36	F	TB	2	yr	fracture of right vertical ramus of the mandible	no surgical treatment	good
37	F	Shet.	7	yr	fig 9B, old frac. of right mandible in interalveolar space	no surgical treatment, flushing of draining tract	good
38	M	App.	6	yr	fracture of right vertical ramus of the mandible	no surgical treatment	good
39	F	QH	3	yr	fig 9B, old frac. of left mandible in interalveolar space, osteomyel.	debridement and removal of P ₂ and P ₃ , antibio.	good
40	F	QH	6	yr	fracture of right vertical ramus of mandible plus fr. in interalveolar space, both with fibrous union	no surgical treatment	good
41	Mc	QH	19	yr	fig 9B, old frac. of right mandible at the level of P ₂ and draining tract	no surgical treatment, flushing of draining tract	good
42	F	Arab	9	yr	fig 9A, minimally displaced fracture of right mandible at level of P ₂	rest	good
43	M	Arab	17	yr	minimally displ. fracture of the maxilla, open into right nostril	no surgical treatment, antibiotics	good

Table 6 (continued)

<u>*</u>	<u>Sex</u>	<u>Breed</u>	<u>Age</u>	<u>Fracture</u>	<u>Fixation</u>	<u>Result</u>
44	F	QH	4 mo	minimally displ. fracture of max. just caudal of incisor teeth	no surgical treatment, antibiotics	good
45	F	QH	9 yr	fig 9B, fracture of left mandible in interalveolar space, draining tract ventral	no surgical treatment, flushing of draining tract	good
46	M	App.	7 da	bilateral mandib. fracture of the vertical rami	fixation of upper and lower jaw with tape, feeding via stomach tube through esophagostomy site	good

maxilla, one of them (*42) involved the mandible. The extensive soft tissue damage in case *35 was surgically repaired.

In three cases (*36, 38, 40) the vertical ramus of one side of the mandible was involved. These fractures were considered stable enough to heal without surgical stabilization.

Four cases (*37, 39, 41, 45) had mandibular fractures of the horizontal ramus that occurred an average of 54 days (10 - 90 days) before presentation at the clinic. All were complicated with osteomyelitis and had a draining tract with a fistula on the ventral border of the bone. These fractures were carefully debrided, freed from all dead tissue, pus and bone sequestrs. In case *39 the first two cheekteeth had to be removed due to alveolar periostitis. Daily flushings of the infected draining tract with isotonic saline or a 2% betadine solution was prescribed until the wound had healed completely. Until complete closure of the wound the patients were treated with antibiotics.

After initial treatment at the clinic, these horses were treated and checked for complications by the referring veterinarians and the owners. The patients of this category were kept at the hospital for an average of four days. One exception was case *46. This foal was kept at the hospital for 28 days.

This suckling foal was presented only a few hours after the injury with a bilateral fracture of the angle of the mandible. It was unable to suckle effectively. To reduce the movement of the jaws and to decrease the possibility of malalignment, a bandage was placed around the foal's jaws. An esophagostomy was performed (Freeman, 1978) and an indwelling stomach tube was left in place for 22 days. During this period the foal was fed foal-lac^h. Later, the foal-lac was supplemented with an alfalfa pellet gruel given by stomach tube. After this period the foal was able to drink and eat pelleted feed.

^h foal-lac^R, Borden Inc., Hampshire, FL 60140

3. Results

From January, 1976 until December, 1984 forty-six horses, one week to 22 years of age, were presented with various histories of trauma to the head that resulted in jaw fractures.

33 out of 46 cases (72%) were mandibular fractures. Only 6 of these involved the mandible caudal to the first cheektooth. The rest, 27 cases, presented with fractures located rostral of P₂ involving the interalveolar space and/or the incisive part of the mandible.

11 out of 46 cases (24%) were maxillary fractures located rostral of the first upper cheektooth.

2 cases presented with both a fracture of the mandible and the maxilla.

27 out of 46 cases (59%) were female horses. 19 out of 46 cases (41%) were male animals or geldings.

A prevalence of any breed in the case load could not be observed.

Of the forty-six horses with jaw fractures forty (87%) recovered well from their injuries. The criteria used to judge the recovery were the following:

- The horses did not show any evidence of ever having had a fracture.
- Their feed intake was sufficient to keep the body in good condition.
- The horses were kept for their intended use.

In category I, fractures of the incisor teeth and the incisive part of the mandible or the maxilla repaired with tension band wiring between incisors; eleven horses had a good recovery with normal function and cosmetics. Horse *2 was lost to follow-up and the result could not be obtained. The injury in horse *4 resulted in a slight malalignment of the second and third incisors of the fractured left side of the mandible. This defect was only cosmetic in nature and did not interfere with normal function for nine years after injury.

Table 7. Success Rate

<u>Category</u>	<u>Number of Cases</u>	<u>Successful Recoveries</u>
I	13 (*1 - 13)	11
Ila	11 (*14 - 24)	8
Ilb	3 (*25 - 27)	3
Ilc	4 (*28 - 31)	3
Ild	1 (*32)	1
III	2 (*33, 34)	2
IV	12 (*35 - 46)	12
<u>Total</u>	<u>46 Cases</u>	<u>40 Successful Recoveries (87%)</u>

Special dental care was not necessary during that period.

In category Ila, fractures through the interalveolar space of the mandible or the maxilla repaired with tension band wiring between incisors and premolars (or canines); eight out of eleven horses had a good recovery. Horse *18 died post-surgically due to salmonellosis. Horse *22 had to be euthanized post-surgically. This patient was unable to rise after surgery because of post-anesthetic recumbency myopathy. Horse *19 resulted in the formation of a parrot mouth (superior prognathism), but this horse was able to maintain its body condition. To control the forming edges on the labial side of the mastication surface of the superior incisor teeth it was sufficient to float them once a year during a routine check-up.

In category Ilb, interalveolar fractures repaired with U-bar fixation; all three horses made a good recovery.

In category IIc, interalveolar fractures with tension band wiring between incisor teeth and a hole drilled horizontally through the mandibular ramus caudal of the fracture line; three out of four horses had a good recovery from their injuries. The injury of horse *30 resulted in a slight malalignment of the incisor teeth. The defect consisted of a slight deviation of the biting surface of the lower incisors compared with the one of the upper incisors. Post-injury care was similar to case *19.

In category IIId, orthopedic wire repair between holes drilled horizontally through the mandible rostral and caudal of the fracture plane; the single horse had a good recovery.

In category III, comminuted fractures repaired with dynamic compression plates; both horses had a good recovery.

In category IV, minimally displaced fractures and old injuries with a draining tract that needed no surgical fixation of the fracture; all twelve horses made an uneventful recovery.

4. Discussion

Forty-six cases of mandibular and maxillary fractures treated by various methods were examined retrospectively.

Fractures involving the very rostral part of the mandible (rostral of the canine teeth) or of the maxilla and separating only a few of the incisors from the rest of the skull (fig 1) were adequately reduced and stabilized with simple wiring around the incisor teeth adjacent to the fracture line (category I).

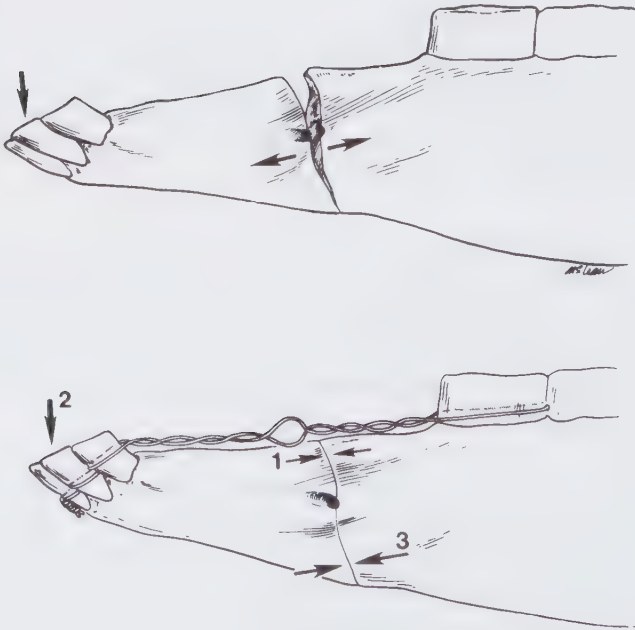
In the presence of a loss of the bony support to the teeth with continual displacement by the forces of mastication, and in the presence of blood clots and feed material in the fracture plane (fig 5), healing without surgical intervention is slow and considerable malalignment of upper and lower incisor teeth generally results. Occlusion would be inadequate, therefore making it difficult for the patient to take in enough feed to support his body condition. This is especially true if the horse has to feed on pasture. In order to graze, the animal needs intact incisor teeth. Also, because these fractures usually exhibit raw bone exposed to the buccal cavity, it is likely that osteomyelitis will develop if left untreated.

Reduction of the fracture gap and stabilization of the fracture fragments can be obtained at surgery and dynamic compression can be maintained by tension band wire application. The occlusional force from the opposite teeth during mastication is converted to compression by tension band wiring and compression rather than displacement results (fig 7). This compression encourages a shorter healing time and prevents malocclusion.

In horses where the fracture line extends caudally all the way back to just rostral of P₂, the fragment may need to be secured additionally with lag screws in order to obtain adequate stabilization (horse *5). This combination technique with tension band wires and cortical bone screws works well if the fracture fragment is too big and unstable for only the application of tension wires. This method is similar to the one described previously by DeBowes (1981). However, we think that in most cases the tension wire application provides sufficient stability and the use of bone screws is not required.

fig 15 This illustration demonstrates a transverse fracture through the interalveolar space being displaced upon mastication.

fig 16 This illustration demonstrates a fracture of type 9B with the accomplished reduction through tension wire placement (arrow 1). Arrow 2 indicates the occlusion forces through mastication. Arrow 3 indicates the resulting compression forces across the fracture.



If the fracture occurred through the interalveolar space or rostral to well developed canine teeth and resulted in the separation of all of the incisor teeth from the jaw (fig 9), tension wires were placed connecting the incisors with the first cheekteeth or the canines (category IIa).

Muscle pull and physiologic occlusion tend to widen the fracture gap (fig 5, 15). The tension surface of the mandible or the maxilla is the lingual surface. Therefore, the tension wires act as tension bands that neutralize the forces separating the fracture fragment changing the displacement forces into compression forces (fig 7, 16). The fracture gap is kept closed by means of the tension wires applied on the tension surface of the bone (arrow 1 in fig 7 and fig 16). The forces of mastication (arrow 2 in fig 7 and fig 16) are transformed into compression of the fracture opposite the tension surface (arrow 3 in fig 7 and fig 16).

In four cases with interalveolar fractures (category IIc), a hole drilled horizontally through each mandibular ramus caudal of the fracture line was used as the caudal anchor for the tension band wires originating from the incisor teeth. The technique is similar to a method previously described (Monin, 1977). However, a brace made from thermoplastic material around the labial side of the incisors was not used.

In two cases of interalveolar fractures, where the fracture could not be stabilized with the intra-oral tension band wiring alone, additional stabilization on the ventral margin of the mandibular horizontal ramus was necessary. In case *17 the oblique placement of lag screws across the fracture was adequate. In case *18, where sufficient bone material was lacking the placement of a dynamic compression plate was necessary. By placing the DCP on the ventro-medial margin the lost shape of the bone could be reconstructed.

In horse *22 pins across the symphysis and cerclage wire around the incisors had to be used to stabilize the symphyseal fracture of the mandible before the intra-oral tension band wires could be applied.

In these cases (*17, 18, 22) the ventral aspect of the mandibular fracture was not stable, e.g. the damaged soft tissue did not prevent the fracture fragment from being pulled orally after tightening of the intra-oral tension wires. The fracture had to be stabilized with additional repair devices such as bone screws or compression plates. However, this is rarely necessary.

In the two surviving cases (*17, 34) where internal fixation devices were used along the ventral border of the mandible we have not seen any problems originating from damage to the alveolar mandibular nerve. According to Brinker, Hohn and Prieur (1984) this nerve is able to heal after having been disrupted by a mandibular fracture in the dog. The nerve runs within the mandibular canal. It leaves the bone via the mental foramen on the lateral side of the mandibular ramus approximately halfway between the third incisor and the first cheektooth. Rostrally it supplies the lower incisor teeth and the lower lip.

When exposing the ventral border of the mandibular bone to apply the compression plate care has to be taken to avoid severing the fascial artery and vein, the parotid duct, the artery of the lower lip and the common labial vein (arteria and vena fascialis, ductus parotideus, arteria labialis mandibularis and vena labialis communis). All these structures run from medial of the mandibular ramus to lateral at the level of the fourth/fifth cheektooth.

Three unstable and comminuted fractures were repaired with a U-shaped brass rod fitted to the tooth arcade as described by Gabel (1969). Horse *25 had an unstable fracture through the interalveolar space of the mandible and the two central incisor teeth were knocked out. Horse *26 had a compression fracture of the premaxilla with caudal displacement of all of the upper incisor teeth. Horse *27 presented with a double level fracture through the interalveolar space of the maxilla. The tightly fitted brass rod secured to the tooth arcade with orthopedic wire provided sufficient stabilization and compression for these fractures and successful healing was achieved. Essentially, the principle of forces that keeps the fracture gap compressed is the same as for the tension band wires. But the brass rod provides more stability in itself than the wires. Therefore, this method is advantageous for the use in compression fractures and unstable fractures.

Horse *34 had a unilateral comminuted fracture of the left mandible cranial of the first cheektooth complicated by osteomyelitis. The first three cheekteeth (all of the premolars) had to be removed because of an infection of the alveoles. A narrow 9-hole dynamic compression plate was used ventro-medially on the aboral margin of the mandible for repair. To insure adequate drainage after surgery a drain was left in place for the first three postoperative days.

Because the fracture was unilateral only and because the premolar teeth were missing an intra-oral tension wire could not be used. The opposite ramus of the mandible was intact and provided enough stability for the fracture to heal. The fact that this fracture healed successfully in the presence of infection was contributed to the very rich blood supply in this area (4) and to the cancellous nature of these bones.

The application of internal fixation devices (plates and screws) in cases of jaw fractures does not seem to be limited to the use in sterile conditions. Therefore, contrary to Piacenza and Böhm (1985), we think that it is unnecessary to euthanize patients with jaw fractures complicated by osteomyelitis, provided that good immobilization and compression can be achieved. These patients must receive adequate antimicrobial therapy.

It is very important to mention that devitalized bone sequesters and pieces of shattered teeth must be removed. If left in place they almost always lead to extensive osteomyelitis and persisting draining tracts as seen in the cases *37, 39, 41, 45 of category IV. These patients were presented to our clinic with a delay after the injury and had not received adequate treatment prior to admission.

Twelve horses (category IV) with minimal displacement of the fracture fragments, old injuries with an already formed fibrous union, simple fractures of the vertical ramus of the mandible, and infected old injuries with persistent draining tracts were treated non-surgically.

Three cases with fracture of one vertical ramus of the mandible (*36, 38, 40) were left without surgical treatment. It seems that these fractures are only minimally displaced and do not need a surgical reposition. The large mass of the masseter muscle prevents displacement and provides adequate stabilization to guarantee healing. In case *33 with a comminuted fracture through the angle of one mandible the fracture was unstable and had to be repaired with a 3.5 mm 6-hole dynamic compression plate.

Four cases (*35, 42, 43, 44) were presented with minimally displaced fracture fragments. Three of them were fractures of the maxilla that are generally less displaced than mandibular fractures. The shape and the mass of this bone plus the protection afforded by the surrounding soft tissues diminish the amount of damage to the maxilla.

Antimicrobial therapy was prescribed until the mucosal lacerations of either nostril or buccal mucosa had healed.

It has to be emphasized that fractures with extensive soft tissue lacerations, exposed bone and radiographically diagnosed bone sequestrs have to be treated aggressively. Careful debridement, cleaning, soft tissue repair and post-surgical wound hygiene are very important. The cases *37, 39, 41, 45 indicate that inadequate treatment of such injuries can lead to osteomyelitis and persisting fistulas. These cases may be treated successfully with antimicrobial therapy (enteral or parenteral) and aggressive local debridement and cleaning.

The suckling foal (*46) with a bilateral fracture of the vertical rami of the mandible was presented only a few hours after the injury had occurred. Generally, a young foal offers a better prognosis than an adult horse for healing of fractures. Due to the more active bone metabolism, healing time is shorter than in adults. The efficient restriction of jaw movements with the bandage and extra-oral feeding (indwelling stomach tube through esophagostomy) supported by the foal's good disposition resulted in rapid fracture healing. It has to be pointed out that very close and time consuming observation of such a case is necessary to insure a positive outcome. This method can only be recommended for fractures of the vertical ramus. If the horizontal ramus is involved the possibility to end up with a severe malocclusion is great. This was also mentioned by Hurtienne and Wissdorf (1972).

In our study, all methods of repair with adequate immobilization of the fracture had a favourable outcome. Two horses had been lost due to causes unrelated to the fractures (*22 had to be euthanized because of postanesthetic recumbency myopathy after a three hour long surgery and *18 died because of salmonellosis after surgery).

The horses were able to eat a normal ration within the first 24 hours after surgery and exhibited very little evidence of pain. The ration consisted of mixed grain and hay. Grazing was not allowed for ten to twelve weeks after surgery. The patients were able to ingest enough feed to maintain their condition without putting unnecessary stress on the repair devices. Grain and hay can be picked up by the horses with their lips only. The mechanism of chewing and the forces being put onto the tension wires became part of the compression of the fractures.

The parrot mouth formation (superior prognathism) in one horse (*19) was due to a three week time lapse between the time of injury and the surgical intervention. In this case it was impossible to reduce the fracture adequately and to obtain perfect alignment.

The resulting malalignment in two cases (*4 and 30) was probably due to insufficient efforts to reduce the fracture or due to the loosening of the repair device. In case *4 the left lower second and third incisor teeth stood slightly out of the arcade of the lower incisors. In case *30 the plane of the biting surface of the lower incisors was slightly deviated in relation to the upper tooth arcade.

However, these malalignments and the superior prognathism were essentially cosmetic failures of the repair and did not interfere with the feeding habits of the horses. Dental problems interfering with mastication were minimal.

In cases of less than optimal occlusion the sharp edges that were developing along the periphery of the mastication surface had to be floated once a year.

The use of tension band wires for the repair of interincisor and interalveolar fractures was in our experience the most recommendable method of repair. The surgeries can be performed with few and inexpensive instruments. A sterile surgery room is optional and aseptical preparation of the surgical field is not necessary. The time needed for surgery is short, therefore reducing expenses and the risks of a long anesthesia. If the tension band wires have to be applied around the incisor teeth, the repair can be done under sedation and local anesthesia with the patient standing. It is very important to mention that the repair devices have to be checked daily or weekly, freed from entrapped feed material and blood coagulas. If necessary, the wires may have to be tightened every day to maintain adequate stability for healing.

5. Summary

Forty-six cases of mandibular and maxillary fractures in horses were reviewed. The injuries were divided into four categories: I, fractures involving the incisor teeth and the incisive part of the maxilla; II, fractures through the interalveolar space of the mandible or the maxilla; III, comminuted fractures; IV, minimally displaced and old injuries.

Depending on the type of fracture one or a combination of the following methods of repair were used to correct the problem: application of tension band wires between the incisor teeth, tension band wires between the incisor teeth and second premolar teeth, fixation with a U-shaped brass rod fitted to the tooth arcade, cerclage wires and pins, compression plates, lag screw fixation or non-surgical treatment.

Out of the forty-six cases, forty (87%) had a good recovery from their injuries. Two horses were lost due to unrelated causes (post-surgical salmonellosis, euthanasia because of post-anesthetic recumbency myopathy). One case was lost to follow-up. The three remaining horses where the outcome was not completely satisfactory included two with a slight malocclusion and one with the formation of a parrot mouth (superior prognathism). The unfavourable results in these three cases were cosmetic in nature and did not interfere with survival and maintenance of normal vital parameters of the horses.

In all fractures in which adequate reduction and dynamic compression could be achieved the outcome was favourable.

Because the principles of the application of intra-oral tension band wires are well accepted mechanically and because the surgeries are simple we can highly recommend this method. However, it is essential to properly select the fractures based on the criteria provided in this article.

6. References

1. Burger, Charles H.: Fracture of an Equine Mandible JAVMA 126, (Feb 1955): 104 - 105.
2. Fischer, R., and Eppenberger W.: Stabile Druckplattenosteosynthese bei Unterkieferfraktur des Rindes. Schweiz. Arch. Tierhk. 108, (1966): 198 - 203.
3. Garner, H.E., and Thurmon J.C.: Repair of Bilateral Fractures of the Maxilla, Premaxilla and Mandible in a Horse. JAVMA 152 (May 1, 1968): 1402 - 1406.
4. Gabel, Albert A.: A Method of Surgical Repair of the Fractured Mandible in the Horse. JAVMA 155, (Dec 15, 1969): 1831 - 1834.
5. Krahwinkel, D.J., Hefferman, H.J., and Ewbank, R.L.: Surgical Repair of Fractured Maxilla and Premaxilla in a Horse. JAVMA 154, (Jan 1, 1969): 53 - 57.
6. Ammann, K.: Eignung der Beckerschen Kunststoffbrücke zur Fixation von Unterkieferfrakturen bei den grossen Haustieren. Schweiz. Arch. Tierhk. 112 (1970): 109 - 112.
7. Wallace, Charles E.: Repair by open Reduction of Fractured Mandible in a Stallion. Austr. Vet. J., Vol. 47, (Feb. 1971): 57 - 60.
8. Hurtienne, H., and Wissdorf, H.: Beitrag zur Behandlung von Frakturen am Kopf des Pferdes. Dtsch. Tierärztl. Wschr. 79 (1972): 597 - 605.
9. Punzet, K.M.: Repair of Bovine and Equine Mandibular Fractures. Can. Vet. J. 21: (March 1980): 69 - 73.

6. References

10. Monin, Thomas: Tension Band Repair of Equine Mandibular Fractures. J. Equine Med. Surg. 1 (1977): 325 - 329.
12. DeBowes, R.M. et al: Lag Screw Fixation of Rostral Mandibular Fractures in the Horse. Vet. Surg., Vol. 10, No. 4 (Oct-Dec 1981) 153 - 158.
13. Ohme, Frederick W., and Prier, James E.: Textbook of Large Animal Surgery. 1st ed. The Williams and Wilkins Company Baltimore, MD (1974): 334 - 337.
14. Freeman, David E., and Naylor, Jonathan M.: Cervical Esophagosomy to Permit Extraoral Feeding of the Horse, JAVMA 172, No. 3, (1978): 314 - 320.
15. Asquith, L. Richard: External Fixation of a Fractured Mandible with Cerclage Wire. Equine Practice Vol. 1, No. 3, (May-June 1979): 37 - 39.
16. Piacenza, C., and Böhm, Dörte: Zur Fraktur des Kiefers beim Pferd unter besonderer Berücksichtigung der Schneidezähne, Berl. Münch. Tierärztl. Wschr. 98, (1985): 181 - 186.
17. Horst, J.: Mandibular Fracture and Fracture Repair in a 26 year old Arab Horse. Br. vet. J. 124, (1968): 140 - 142.
18. Brinker, W. O., Hohn, R. B., and Prieur, W. D.: Manual of Internal Fixation in Small Animals. Springer Verlag, Berlin, Heidelberg, New York, Tokyo (1984).

Many thanks to all who helped to finish this paper.

Especially to:

- Dr. L.R. Bramlage for his recommendation of the subject and continuing support
- Prof. Dr. P.F. Suter for his constructive and honest critique of the manuscript
- Prof. Dr. A.A. Gabel for his approval and support of the paper
- Ron McClean for the illustrations
- Marian Miller for the photography
- Miss B. Ramsauer for the typing of the manuscript
- The staff of medical records and radiography of the College of Veterinary Medicine, The Ohio State University
- My wife Linda for the grammatical correction of the manuscript and her personal support

Lebenslauf

Geboren:	9. Juni 1954 in Herisau AR																										
Bürger:	Teufen AR																										
Eltern:	Hans und Elisabeth Loppacher, geborene Streiff																										
Ausbildung:	<table><tr><td>1961 - 1967</td><td>Primarschule in Herisau</td></tr><tr><td>1967 - 1969</td><td>Sekundarschule in Herisau</td></tr><tr><td>1969 - 1974</td><td>Kantonsschule in St. Gallen</td></tr><tr><td>1974</td><td>Matura Typus C</td></tr><tr><td>1976 - 1977</td><td>Universität Lausanne</td></tr><tr><td></td><td>2 Semester Medizinstudium</td></tr><tr><td>1977 - 1981</td><td>Universität Zürich</td></tr><tr><td></td><td>Studium der Veterinärmedizin</td></tr><tr><td>1981</td><td>Staatsexamen</td></tr><tr><td>1981 - 1983</td><td>Praxisvertretungen bei praktischen Tierärzten in der Schweiz und in Deutschland</td></tr><tr><td></td><td>Praktikum in der Veterinärchirurgischen Grosstierklinik der Universität Zürich</td></tr><tr><td>1983 - 1985</td><td>Resident an der Ohio State University, Department of Equine Medicine and Surgery (Prof. Dr. A.A. Gabel)</td></tr><tr><td>1985 - 1986</td><td>Assistent in Grosstier- und Pferdepraxis</td></tr></table>	1961 - 1967	Primarschule in Herisau	1967 - 1969	Sekundarschule in Herisau	1969 - 1974	Kantonsschule in St. Gallen	1974	Matura Typus C	1976 - 1977	Universität Lausanne		2 Semester Medizinstudium	1977 - 1981	Universität Zürich		Studium der Veterinärmedizin	1981	Staatsexamen	1981 - 1983	Praxisvertretungen bei praktischen Tierärzten in der Schweiz und in Deutschland		Praktikum in der Veterinärchirurgischen Grosstierklinik der Universität Zürich	1983 - 1985	Resident an der Ohio State University, Department of Equine Medicine and Surgery (Prof. Dr. A.A. Gabel)	1985 - 1986	Assistent in Grosstier- und Pferdepraxis
1961 - 1967	Primarschule in Herisau																										
1967 - 1969	Sekundarschule in Herisau																										
1969 - 1974	Kantonsschule in St. Gallen																										
1974	Matura Typus C																										
1976 - 1977	Universität Lausanne																										
	2 Semester Medizinstudium																										
1977 - 1981	Universität Zürich																										
	Studium der Veterinärmedizin																										
1981	Staatsexamen																										
1981 - 1983	Praxisvertretungen bei praktischen Tierärzten in der Schweiz und in Deutschland																										
	Praktikum in der Veterinärchirurgischen Grosstierklinik der Universität Zürich																										
1983 - 1985	Resident an der Ohio State University, Department of Equine Medicine and Surgery (Prof. Dr. A.A. Gabel)																										
1985 - 1986	Assistent in Grosstier- und Pferdepraxis																										

